

WHAT IS CLAIMED IS:

1           1.    An intermittent short circuit determining device  
2    located between a power source and a load circuit in a  
3    vehicle electric circuit, the intermittent short circuit  
4    determining device comprising:

5                means for detecting current flowing through the load  
6    circuit;

7                means for determining whether the current detected by  
8    the detecting means is an intermittent short circuit;

9                means for disconnecting the load circuit when the  
10   determining means determines that there is an intermittent  
11   short circuit;

12               wherein the determining means is selectively connected  
13   to an external switch circuit, which supplies and stops  
14   current to the load circuit, and wherein the determining  
15   means determines whether the external switch circuit is  
16   switched on or off, and switches the disconnecting means on  
17   or off according to said determination.

1           2.    The intermittent short circuit determining device  
2    according to claim 1, wherein a fuse is included in the  
3    detecting means.

1           3.    The intermittent short circuit determining device  
2    according to claim 1, wherein a semi-conductor relay is  
3    included in the disconnecting means.

1           4.    The intermittent short circuit determining device  
2    according to claim 1, wherein the detecting means, the  
3    determining means, and the disconnecting means are  
4    integrally packaged.

1           5.    The intermittent short circuit determining device  
2    according to claim 1, wherein the detecting means is one of

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3 a plurality of detecting means, and each of the detecting  
4 means corresponds to a load circuit from a plurality of load  
5 circuits, respectively, wherein the disconnecting means is  
6 one of a plurality of disconnecting means, and each of the  
7 disconnecting means corresponds to a load circuit from said  
8 plurality of load circuits, respectively, wherein the  
9 determining means is connected to the plurality of detecting  
10 means and the plurality of disconnecting means, and the  
11 determining means is connected to a plurality of external  
12 switch circuits corresponding to the plurality of load  
13 circuits, respectively, and each external switch circuit  
14 selectively supplies and stops current to the load circuit,  
15 and wherein the determining means determines whether the  
16 plurality of external switch circuits are switched on or  
17 off, and selectively switches the disconnecting means on or  
18 off according to said determination.

1 6. The intermittent short circuit determining device  
2 according to claim 1, wherein the detecting means is one of  
3 a plurality of detecting means, and each of the detecting  
4 means corresponds to a load circuit from a plurality of load  
5 circuits, respectively, wherein the disconnecting means is  
6 connected between a power source and the plurality of  
7 detecting means, and the disconnecting means is able to stop  
8 load current supplied to all of the load circuits, and  
9 wherein the determining means is one of a plurality of  
10 determining means, and each determining means is selectively  
11 connected to one of a plurality of external switch circuits,  
12 and the plurality of external switch circuits corresponds to  
13 the plurality of load circuits, respectively, and each  
14 external switch circuit selectively supplies and stops  
15 current to the load circuit, and wherein each determining  
16 means determines whether the external switch circuit is  
17 switched on or off, and selectively switches the  
18 disconnecting means on or off according to said

19 determination.

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1 7. The intermittent short circuit determining device  
2 according to claim 1, wherein the detecting means is one of  
3 a plurality of detecting means, and each of the detecting  
4 means corresponds to a load circuit from a plurality of load  
5 circuits, respectively, wherein the disconnecting means is  
6 one of a plurality of disconnecting means, and each of the  
7 plurality of disconnecting means corresponds to a load  
8 circuit from the plurality of load circuits, respectively,  
9 and wherein the determining means is one of a plurality of  
10 determining means, and each determining means is selectively  
11 connected to one of a plurality of external switch circuits,  
12 and each external switch circuit from the plurality of  
13 external switch circuits corresponds to a load circuit from  
14 the plurality of load circuits, respectively, and each  
15 external switch circuit selectively supplies and stops  
16 current to the load circuit, and wherein each determining  
17 means determines whether the external switch circuit is  
18 switched on or off, and switches the disconnecting means on  
19 or off according to the determination.

1 8. The intermittent short circuit determining device  
2 according to claim 7, wherein each of the plurality of  
3 detecting means is connected to a corresponding separate  
4 power source, and each of the plurality of disconnecting  
5 means is able to stop the load current supplied from the  
6 corresponding power source.

1 9. An intermittent short circuit determining device  
2 for determining whether an intermittent short circuit has  
3 occurred in a load circuit, the intermittent short circuit  
4 determining device comprising:  
5 means for detecting a load current flowing through the  
6 load circuit and for generating a detection signal;

7           determining means connected to the detecting means,  
8       wherein the determining means determines whether an  
9       intermittent short circuit has occurred based on the  
10      detection signal;

11           and disconnecting means connected to the determining  
12      means, wherein the disconnecting means stops supply of the  
13      load current to the load circuit when it is determined that  
14      an intermittent short circuit has occurred, wherein the  
15      determining means determines whether an intermittent short  
16      circuit has occurred based on at least one of four  
17      characteristic quantities, which include the load current  
18      flowing through the load circuit, a time period during which  
19      the load current exceeds a predetermined current threshold  
20      value, an ON-duty ratio indicating the ratio of a time  
21      period when the load current exceeds the current threshold  
22      value relative to a predetermined time period, and an actual  
23      over-current number indicating the number of times that the  
24      load current exceeds the current threshold value during a  
25      predetermined time period, and wherein the determining means  
26      switches the disconnecting means on or off according to said  
27      determination.

1           10. The intermittent short circuit determining device  
2      according to claim 9, wherein the detecting means, the  
3      determining means, and the disconnecting means are  
4      integrally packaged.

1           11. The intermittent short circuit determining device  
2      according to claim 9, wherein when at least two of the four  
3      characteristic quantities exceed predetermined reference  
4      values, the determining means determines that an  
5      intermittent short circuit has occurred.

1           12. The intermittent short circuit determining device  
2      according to claim 11, wherein the detecting means, the

1 determining means, and the disconnecting means are  
2 integrally packaged.

1 13. The intermittent short circuit determining device  
2 according to claim 9, wherein the determining means includes  
3 a processing circuit which generates a current flow  
4 permission signal and a current shutdown signal wherein the  
5 current flow permission signal activates the disconnecting  
6 means and allows the load current to flow, and the current  
7 shutdown signal inactivates the disconnecting means and  
8 stops the load current.

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1 14. The intermittent short circuit determining device  
2 according to claim 9, wherein the current threshold value is  
3 one of a plurality of current threshold values, and the  
4 plurality of current threshold values defines a plurality of  
5 load current ranges, and each of the plurality of load  
6 current ranges is associated with at least one of a  
7 reference ON-duty ratio and a reference over-current number,  
8 and the determining means compares the load current with the  
9 plurality of current threshold values and identifies a load  
10 current range wherein the load current belongs, and when at  
11 least one of the ON-duty ratio and the actual over-current  
12 number exceeds the corresponding reference value associated  
13 with the identified load current range, the determining  
14 means determines that an intermittent short circuit has  
15 occurred.

1 15. The intermittent short circuit determining device  
2 according to claim 14, wherein the determining means  
3 includes a storage device for storing the plurality of  
4 current threshold values and at least one of the reference  
5 ON-duty ratio and the reference over-current number.

1 16. A method for determining the occurrence of an

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intermittent short circuit in a load circuit, wherein the method includes performing at least one of four comparing steps including a current comparison step, a time period comparison step, a duty ratio comparison step, and an over-current number comparison step, wherein the current comparison step comprises comparing the value of load current flowing through the load circuit with a current threshold value, the time period comparing step comprises comparing a time period during which the load current exceeds the current threshold value with a reference time period, the duty ratio comparison step comprises comparing an ON-duty ratio with a reference ON-duty ration, where the ON-duty ratio indicates the ratio of a time period during which the load current exceeds the current threshold value relative to a predetermined time period, and the over-current number comparison step comprises comparing an actual over-current number indicating the number of the times that the load current exceeds the current threshold value during the predetermined time period with a reference over-current number.

17. The determining method according to claim 16, wherein the current threshold value is one of a plurality of current threshold values, and the plurality of current threshold values defines a plurality of load current ranges, and each of the plurality of load current ranges is associated with at least one of the reference ON-duty ratio and the reference over-current number, wherein the current comparing step includes comparing the load current with the plurality of current threshold values and determining a load current range to which the load current belongs, and the determining method further includes determining that an intermittent short circuit has occurred when at least one of the ON-duty ratio and the actual over-current number exceeds the corresponding reference value associated with the

15 determined load current range.

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1 18. A method for determining the occurrence of an  
2 intermittent short circuit in a load circuit, wherein the  
3 method includes at least two of four comparing steps  
4 including a current comparison step, a time period  
5 comparison step, a duty ratio comparison step, and an  
6 overcurrent number comparison step, wherein the current  
7 comparison step comprises comparing the value of a load  
8 current flowing through the load circuit with a current  
9 threshold value, the time period comparing step comprises  
10 comparing a time period during which the load current  
11 exceeds the current threshold value with a reference time  
12 period, the duty ratio comparison step comprises comparing  
13 an ON-duty ratio with a reference ON-duty ratio, and the ON-  
14 duty ratio indicates the ratio of a time period during which  
15 the load current exceeds the current threshold value  
16 relative to a predetermined time period, and the over-  
17 current number comparison step comprises comparing an actual  
18 over-current number indicating the number of times that the  
19 load current exceeds the current threshold value during the  
20 predetermined time period with a reference over-current  
21 number.

1 19. The determining method according to claim18,  
2 wherein the current threshold value is one of a plurality of  
3 current threshold values, and the plurality of current  
4 threshold values define a plurality of load current ranges,  
5 and each of the plurality of load current ranges is  
6 associated with at least one of the reference ON-duty ratio  
7 and the reference over-current number, wherein the current  
8 comparing step includes comparing the load current with the  
9 plurality of current threshold values and determining a load  
10 current range to which the load current belongs, and the  
11 determining method further includes determining that an

intermittent short circuit has occurred when at least one of the ON-duty ratio and the actual overcurrent number exceeds the corresponding reference value associated with the determined load current range.

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20. A method for determining whether an intermittent short circuit has occurred in a load circuit, the method comprising:

- comparing a load current that flows in the load circuit with a first current threshold value;
- comparing the load current with a second current threshold value, the second current threshold value being greater than the first current threshold value;
- comparing a first time period, during which the load current exceeds the first current threshold value, with a first reference time period;
- comparing a second time period, during which the load current exceeds the second current threshold value, with a second reference time period;
- comparing an ON-duty ratio with a reference ON-duty ratio wherein the on-duty ratio is the ratio of a time period when the load current exceeds the second current threshold value relative to a predetermined time period; and
- comparing an overcurrent number with a reference overcurrent number, wherein the overcurrent number is the number of times that the load current exceeds the second current threshold value during a predetermined time period.

21. The determining method according to claim 20, wherein the method further comprises:

- determining that when the load current exceeds the first current threshold value and when the first time period exceeds the first reference time period, an intermittent short circuit has occurred;
- determining that when the load current exceeds the



8 second current threshold value and when the second time  
9 period exceeds the second reference time period, an  
10 intermittent short circuit has occurred;

11 determining that when the load current exceeds the  
12 second current threshold value and when the ON-duty ratio  
13 exceeds the reference on-duty ratio an intermittent short  
14 circuit has occurred; and

15 determining that when the load current exceeds the  
16 second current threshold value and when the actual over-  
17 current number exceeds the reference over-current number,  
18 and intermittent short circuit has occurred.

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